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# RA DAR

## IT HAS A SELFISH MOTIVE

By JOHN BIRCH, E.E. III

PROPAGANDISTS, both Axis and Allied, devote considerable time and mental effort to dreaming up claims for new "secret weapons," claims which are very ineffectual against the enemy.

That one of these dreams became a reality, however, is now a matter of record. For radar, the most significant weapon developed in the present war to date, underwent the transition from secrecy to history on May 23 of this year with the issuance by the Navy of a paper describing its development.

A vivid testimony of the effectiveness of radar as a defensive weapon can be obtained from the German *Luftwaffe*, a group now richer in experience, though lesser in number. In 1940, Hitler's airmen suffered their first defeat at the hands of the RAF, which was outnumbered 10 to 1. Turning to night raids for better luck, German bombers were sought out and destroyed with equal ease, regardless of altitude. Apparently, the British were receiving advance notice of the raids and consequently could concentrate their airpower to a better advantage. The death rate of German planes was so high that the invasion of England had to be postponed indefinitely. For this civilization-preserving feat, radar was almost entirely responsible.

The Nazis were wiser as a result of this experience, of course, but not until it was too late. They had an inkling of the idea from apparatus in captured planes, and their findings were confirmed on July 17, 1941, when it became absolutely necessary for Lord Beaverbrook to broadcast an appeal for desperately needed radio technicians for radar servicing. Scraping together every bit of information they could get their hands on, the Germans hurriedly built a radar station on the channel. Upon its completion, English commandos took it, lock, stock and barrel.

The principles behind this new piece of electronic thaumaturgy are simple, fundamental, and have been known for many years. Radar exists in its most basic form in the bat, which is blind but "sees" by emitting a very high pitched whistle which bounces off its surroundings and returns to its sensitive ears, enabling it to approximate distances. In actual practice, a receiver and

transmitter of radio waves are the main components of the apparatus used, both being necessary at each station. The transmitter sends out waves of extremely short wave length (1 to 10 cm.); the waves travel in a straight line, with the speed of light, until they strike an electricity-conducting surface. They are then reflected back to the sending station and are detected in the receiver, the time for the entire cycle to occur being recorded by sensitive instruments. It is then possible to obtain the distance to the reflecting surface.

Notice that this resembles the well-known echo effect, but with radio waves involved rather than sound waves. As with sound waves, the reflecting body governs the strength and clarity of the echo. It is surprising, but indeed fortunate, that an object as small as an airplane could reflect the signals adequately to make them audible at the receiving post at a distance of one hundred miles, but such is the case, and mainly because of two practices in the *modus operandi*. First, the very short wave lengths are used, resulting in a sharper, more intense reflection. The signal will not spread out, but will continue to travel in a concentrated beam (quasi-optical phenomenon). And second, by various arrangements of the antenna wires it is possible to make the waves travel in any desired direction, which creates the same effect. With the searching-out signal traveling in a narrow beam, the *direction* of the reflecting airplane can be more accurately obtained.

With radar, it is possible to determine the number, speed, altitude, and course of approaching planes, but this cannot be done from one unit alone, (a unit consisting of one transmitter and one receiver). As the detecting system is set up, a number of units are used at remote points, while the recording instruments are all located at a central control position. In this way, the results of all the units can be co-ordinated and utilized in the familiar "triangulation" method of surveying.

The unerring accuracy of this system was illustrated tragically at Pearl Harbor. Radar units had been assigned to the Pacific fleet the year before, and the station at Pearl Harbor was being operated by a Pvt. Lockhard. On Dec. 7, 1941, while experimenting with the station, he

detected a large group of planes approaching 132 miles distant and immediately reported to his superior officers. They retorted that a large number of American planes were due, and promptly forgot the matter. Fifteen minutes later, Lockhard observed that the planes were 90 miles away and 50 in number. When a further increase in signal strength was noticed, he again reported, at the risk of insubordination, and again failed to cause any alarm. Events that followed are only too well known.

In 1925, two scientists, Kennelly and Heaviside, found that when radio waves were directed upward, they were reflected back to earth. Their explanation was that there exists layers of ions in the statosphere, which reflect the waves. The device which was designed to measure the height of these layers became the first efficient radar set because it overcame an inherent difficulty. Since the transmitter, for sending out the waves, and the receiver, for intercepting the reflected waves, had to be placed rather closely together, it was only natural that some energy would "leak out" of the transmitter and go directly over to the receiver, thus causing interference. The problem was solved by transmitting the signal in short pulses, the "dead" space between pulses being long enough to permit reception of the reflected signal. The pulse system did not receive full recognition until 1932.

The development of radar continued slowly in

the 1930's because of lack of money (due to failure to gain congressional support), and time. But when a perfected radar unit gave an excellent account of itself in 1939 on the battleship *New York*, the Navy was completely convinced of its value, and immediately the Bell Telephone and R.C.A. electronics laboratories organized for quantity production.

In those days, nations weren't trading scientific secrets, and it wasn't until late in 1940 that we learned that Great Britain had developed, independently, radar equipment very similar to that of the U. S. Navy. Their work was based on American papers of the late 1920's concerning the Heaviside layer measurements. Radar is now being adopted by all the nations taking an active part in the war.

About radar having a future there is no question. The very qualities which make it an invaluable wartime weapon will qualify it for undreamed of uses in peacetime. Our trains, super liners, and high speed planes will be protected by radar from the increased danger of collision. Astronomers will use it to study the moon and planets. Meteorologists will be able to detect cloud masses thousands of miles away and make more accurate weather predictions.

Indeed, radar has a selfish motive. It is shortening the war by a tremendous, bloodless, amount, that it may hurry and busy itself with the task of enlightening the world of tomorrow.



Transmitters on the assembly floor

—Courtesy General Electric.